Do Potted-Plants Improve the Indoor Environment?

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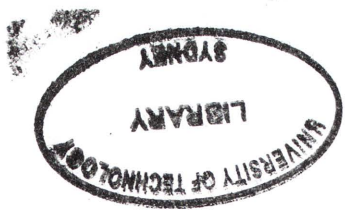
Certificate of Authorship/Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Candidate Date

28/07/11



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ABPA	Acute Bronchopulmonary Aspergillosis
ANCOVA	Analysis of Co-Variance
ANOSIM	Analysis of Similarity
ANOVA	Analysis of Variation
CAM	Crassulacean Acid metabolism
HVAC	Heating, Ventilation and Air Conditioning
IAQ	Indoor Air Quality
IEQ	Indoor Environmental Quality
LRC	Light Response Curve
PDA	Potato Dextrose Agar
RBC	Rose Bengal Chloramphenicol Agar
SBS	Sick Building Syndrome
SDX	Sabouraud Dextrose Agar
TVOC	Total Volatile Organic Compound
UAP	Urban Air Pollution
VOC	Volatile Organic Compound
WHO	World Health Organisation
± SE	Standard Error of the mean

Abstract

With increasing prevalence of urban air pollution (UAP), associated problems are becoming of major international concern environmentally, economically and with respect to human health. About 50% of the world's population (including 80% of Australians) live in urban areas and spend approximately 90% of their life indoors, where indoor air quality (IAQ) is almost always more polluted than outdoors, even in urban centres with the high reliance on fossil fuels for transport and industry. An increasing proportion of urban dwellers work in sealed buildings, dependent for air supply and thermal comfort on heating, ventilating, and air conditioning (HVAC) systems. This project investigated the potential benefits for more sustainable cities, that could be achieved by using potted-plants as a supplement to HVAC systems, with the added benefits of decreasing the incidence of sick building syndrome (SBS), and of lowering the carbon footprint of a city.

The research considered three major aspects of IAQ. Indoor plants have been shown to be able to significantly reduce levels of CO_2 and volatile organic compounds (VOCs), two classes of contaminants almost always found in higher concentrations indoors than outside. However, they have also been named as a likely source of pathogenic mould spores, and this was also investigated. An office field study was conducted in which the effects were tested of four plant treatments using *Dracaena marginate* 'Janet Craig' and *Spathiphyllum wallisii* 'petite' (plus reference offices) on a range of IAQ parameters: CO_2, VOCs, temperature, relative humidity; plus airborne mould spore abundance and diversity. Laboratory studies were also carried out, on the capabilities of plants to: reduce CO_2 at different light intensities and from two different light acclimation intensities; remove benzene (as model VOC) applied at various dosages; and contribute to air-borne mould spore concentrations and species diversity.

Through the laboratory test-chamber studies it was shown that the three species tested; *Aglaonema modestum, Chamaedorea elegans and Philodendron* 'Congo' had the ability to remove the 8-hour averaged exposure limit after an induction period. Also plants were readily capable of reducing chamber CO_2 by up to 90% within one hour, under favourable lighting intensities and after two light acclimation levels. The mould studies revealed that, compared with outdoor air, there were 8–15 times lower mould spore loads indoors, and there was little correlation between the mould genera found in potting mix soil with those found in office air. The results indicate that it is unlikely that potted-plants are significantly contributing to the levels of moulds found in the air in Sydney. The office study, in two relatively new buildings, demonstrated that, with modern HVAC systems, indoor plants had little to no impact on IAQ, with no significant differences between offices with plants and those without. This is at variance with a previous study from this laboratory using two buildings with much older HVAC systems, and one with no air conditioning. Thus it appears that modern HVACs can mask any benefits of plants on IAQ. This result opens up the possibility of reducing the energy load on the HVAC system by allowing plants to play a greater role in cleaning indoor air. The results obtained in this study are very promising for future indoor environmental management. The possibility of reducing urban air pollution by lowering energy requirements of city buildings is also encouraging and, in a time of

emission trading schemes and carbon taxes, nature's ability to cost-effectively mitigate urban pollution is impressive, and its development is urgently needed.